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SNOW'S WORK ON CHLOROFORM.

By DUDLEY WILMOT BUXTON, M.D., B.S., M.R.C.P.,
Consulting Anæsthetist to University College Hospital.

ON the 10th November 1847, Dr. J. Y. Simpson, as he then was, communicated to the Medico-Chirurgical Society of Edinburgh his paper entitled "Notice of a New Anæsthetic Agent as a Substitute for Sulphuric Ether in Surgery and Midwifery." It was dedicated to M. J. Dumas, the eminent French chemist, and sets forth in a concise manner Simpson's first experiences with chloroform. In a private letter sent by him to Dr. Prothero Smith, to whom he had sent a proof copy of the pamphlet, he writes: "Here [*i.e.* in Scotland] we are all *wild* on the subject." The wording of the paper, however, is free from exaggeration and contains little information about the great discovery. It states that chloroform is exempt from the disadvantages of ether as then administered; that no inhaling apparatus is required, and that in tooth extraction and minor surgery, as well as in a few cases of midwifery, this agent had been employed, and found to be conspicuously successful. A few words borrowed from manuals on chemistry are added, which describe the pharmacological aspect of "perchloride of Formyle," and that is all. The plan of administering the drug suggested is to pour "a little of the liquid diffused upon the interior of a hollow-shaped sponge or a pocket-handkerchief or a piece of linen or paper and held over the mouth and nostrils." This method Simpson adhered to in his later papers. He used half a drachm, and, puckering the handkerchief into the shape of a cup, he at first held it half an inch from the face,

later applying it close to the mouth. In none of the succeeding papers do we find any attempt to explain the physiological action of this narcotic, or to trace the best method of preventing overdosage. Indeed, it would seem that although Simpson definitely stated that danger and even death may follow its employment, yet such contingencies were, in his view, highly improbable, and were due to lack of knowledge on the part of the administrators. When several deaths were recorded Simpson wrote explaining them away and in many cases asserting that the fatalities were due to causes other than the action of chloroform. It is remarkable that in the history of anæsthesia we find that those who were enthusiastic about certain agents or certain methods have been prone to gloss over the accidents which to the plain man appear to be the direct result of the agents or the methods of their employment.

Thus was initiated the unscientific system of the use of chloroform, "unmeasured chloroform, but plenty of air," a system which the reputation of Simpson and the vigorous advocacy of Syme and those who followed him rendered almost a cult. It must be remembered that fatalities were at first few, while of these many were attributed to any cause other than an overdosage by chloroform. This state of things could only have arisen through neglect of the study of the action of the drug upon the animal organism. The surgeons of those days, with whom the use of chloroform rested, it is true, were giants, but they were not physiologists.

Snow, as we have seen, was a thinker, and one who preferred to seek truth by experiment rather than to be led away by enthusiasm. As soon as Simpson's historic pronouncement on chloroform was made common knowledge, Snow commenced his exhaustive research on "Narcotism by the Inhalation of Vapours." This was published in the *London Medical Gazette* in 1848, and took cognizance of ether, chloroform, Dutch liquid, bromoform, bisulphide of carbon and many other bodies. Of these we need only pursue the work which dealt with chloroform.

Snow, in his experiments upon lower animals, set himself to discover what was the effect of different percentage strengths of the drug. First the phenomena of tenuous vapours, then the strength requisite to induce complete insensibility without

interference with the essential vital processes, and, lastly, the happenings, including death, which arose when the strength of the vapour inhaled was gradually or suddenly increased to greater strength. He wrote: "The great point to be observed in causing insensibility by any narcotic vapour is to present to the patient such a mixture of vapour and air as will produce its effects gradually and enable the medical man to stop at the right moment. Insensibility is not caused so much by giving a dose as by performing a process." He insisted that the vapour tension in the mixture must vary as the temperature rises, so that what would produce a safely respirable mixture at one temperature would give a dangerously high percentage at another.

The experiments convinced Snow that definite quantities of chloroform vaporised in air did in all cases produce the phenomena which he grouped as the five *degrees* of narcotism. He insisted that it is more scientific to speak of "degrees" rather than of "stages," since the phenomena of recovery from chloroform narcosis are similar to those of induction, and so to refer to a stage of excitement, for example, is to open the door to misconception since excitement reveals itself in the second degree of narcotism, and again during recovery. The conclusions to which he arrived are that a 2 per cent. vapour of chloroform in air produces unconsciousness and a condition of true surgical anæsthesia. Further, that when this strength of vapour is exceeded the respiration becomes embarrassed, and if the inhalation is continued the breathing ultimately ceases. In the case of the lower animals removal from the atmosphere of chloroform will lead to recovery when the vapour breathed has been not greatly above 2 per cent., but if the percentage is above 4 or 5 per cent., and is breathed continuously, death will ensue.

With reference to the lethal dose, he writes: "I have not yet been able to determine satisfactorily the exact proportion of chloroform which requires to be absorbed to arrest the respiration of animals of warm blood. I believe there is a definite proportion which has this effect, but there are two reasons why it is not so easy to ascertain it as to ascertain the proportion which causes minor degrees of narcotism. In the first place, the breathing often becomes very feeble before it ceases, so

that the animal inhales and absorbs but little chloroform, and remains on the brink of dying for some time. In the next place, the temperature of the body falls in a deep state of narcotism, especially in small animals; and as the temperature falls the amount of chloroform which the blood can dissolve from any given mixture of air and vapour increases."* From this and other passages it would appear that Snow clearly grasped the fact, now well established, that, so far as respiration is concerned chloroform acts, firstly, as a result of the strength of the vapour inhaled, and, secondly, as the result of the cumulative effect of the chloroform which becomes stored in the tissues of the animal body. It does not appear that Snow or the physiologists of his day appreciated that chloroform is not only a narcotic but is also a protoplasm poison.

Two important points must be noted at this stage of our study of Snow's teaching; the one is that he is dealing for the nonce solely with the effects of the drug upon the respiration, while any interference with the circulation and other vital processes are dealt with only as the result of respiratory embarrassment or failure. The other point is that at the time of his experiments an interrupted rather than a continuous system of inhalation was practised. The patient was made anæsthetic and then the inhalation was withheld until the administrator judged that the narcosis was becoming too shallow for the needs of the operator, when a renewal of the inhalation was allowed. The types of operations then in vogue permitted such a method; there were practically no deep dissections and no abdominal surgery, so that a surgeon would complete his labours in a much shorter time than obtains to-day.

Snow and others attempted to estimate the total quantity of blood in the circulation, and aimed at supplying so much chloroform as would produce various degrees of partial saturation. He calculates that certain percentages of vapour in air would necessarily cause a definite degree of saturation, and this would cause the definite phenomena of a progressive narcotism to emerge. In fact, he pioneered one of the lines

* "On Chloroform and other Anæsthetics," p. 69, *et passim*.

of the work of the Special Chloroform Committee of the British Medical Association published in 1911, and it is remarkable that with the scanty physiological knowledge existent in his day and the complete absence of accurate apparatus, that his results tally closely with those obtained by those engaged in the later research.

To return. Snow ultimately came to the conclusion, so far as respiration is concerned, that double the strength of vapour which induced anæsthesia would, if continuously inhaled cause death. Thus he taught that 2 per cent. led to anæsthesia; 4 per cent. was the lethal dose. As we shall see in the sequel, Snow nominally employed a 4 per cent. and even 5 per cent. mixture, and met with few fatalities. How can these apparent contradictions be reconciled? The discrepancy is more apparent than real, for Snow opposed any method of giving chloroform which was not sufficiently under the control of the administrator to allow him to restrict the strength of the vapour to his estimate of the requirements of the patient. To do this effectually he designed an inhaler which, although graded to supply a percentage up to 5 per cent., yet had valves under control of the anæsthetist which permitted a gradually increasing strength of vapour. The possible 4 per cent. or 5 per cent. seems seldom, if ever, to have been reached, at least wittingly. Further, as mentioned above, at no time was the use of a high percentage persistently adopted, nor was it used at the commencement of the inhalation.

A further result of his investigations brought Snow into direct antagonism with Simpson and those who followed what grew to be called "the Scotch" method of chloroformisation. He wrote calmly but vigorously anent the dangers of "unstinted chloroform," which, even in the hands of experienced surgeons such as those of Simpson himself were, Snow averred, fraught with danger. It would certainly appear that so convinced of its safety were the early advocates of the use of chloroform that their methods were crude if not casual. Snow quotes Professor Miller, who, in his "Surgical Experiences of Chloroform," describes the plans adopted in the Royal Infirmary of Edinburgh. "Anything that will admit of chloroform in vapour being brought fully in contact with the mouth and nostrils: a handkerchief, a

towel, a piece of lint, a worsted glove, a nightcap, a sponge," was used; the glove or nightcap being especially in vogue during cold weather. Professor Miller adds: "The object is to produce insensibility as completely and as soon as we can . . . whether it is done with fifty drops or five hundred is unimportant."

Snow's inhaler was a distinct advance. In principle it consisted of a metal inhaler warmed with hot water, the chloroform was not "spilt" as Professor Miller advised, but dropped in measured quantity upon coils of bibulous paper. The arrangement of these formed an important part of Snow's technique. The vapour was allowed to pass through a long mohair tube to Sibson's valved facepiece, which last covered the mouth and nostrils and was guarded by inspiratory and expiratory valves. The inhaler was supposed to supply a 4 per cent. or even a 5 per cent. vapour, and this was diluted at the discretion of the administrator by opening or closing the inspiration valve. It is clear that so large a dead space and valve permitting the free entrance of air would materially lower the initial strength of the vapour. A low percentage strength was used at first, and this was gradually increased as time went on until anæsthesia being attained the inhaler was removed and reapplied as the exigencies of the case required. That this plan, although a great advance upon the crude methods advocated by professor Miller, fell short of ideals is shown by the fact that several deaths occurred during its use, and even in the practice of so skilled and philosophic an administrator as Snow.

Experimenting upon himself, Snow filled bags with known percentages of vapour, and arrived at results identical with those obtained in his research experiments. He admits such a procedure was the safest, but contends that some risk falling short of perfection might be allowed in order to simplify the procedure.

No doubt Clover's chloroform bag owed its origin to Snow's suggestion, and replaced in the former's practice the dangerous plan he initiated of applying to the patient's face lint wetted with the reagent and covering this with a towel. It is interesting to note that Clover met with no

deaths while using the lint and towel system, although others were less fortunate.

Up to this point we have dealt with Snow's views of chloroform so far as respiration is concerned, but that astute observer soon found that another and greater danger arose when the strength of the vapour inhaled was greater than those which induced death gradually by paralyzing respiration. He reasoned that chloroform given continuously in vapours of 4 per cent. or over produced effects upon the central nervous system, and did so when the blood had absorbed its optimum of safe saturation, but if a strong vapour was suddenly presented to the patient it passed, so Snow taught, through the coronary circulation to the heart and caused cessation of the general circulation even before the anæsthetising effect upon the brain had been produced. The cessation of breathing was immediate, the poisoning of the heart was fatal. It is of interest to note that in some of the animals killed by high percentages of chloroform the autopsy showed inchoate twitching of isolated bundles of muscular fibres in the myocardium, a phenomenon which has been studied by Professor MacWilliam and called by him *delirium cordis*. Snow also appears to have recognized that it was not the mass amount of chloroform which passed through the heart but the strength of the vapour which caused death.

Snow made some important experiments upon the analgesic effects of chloroform, confirming his views from the stores of his wide clinical experience. He differentiates sharply the central nervous- or brain-induced anæsthesia from the lessening or loss of common sensibility. This last, he points out, " does not keep pace with the degree of narcotism of the brain as shown by the presence or absence of consciousness and volition." This must depend upon the chloroform acting upon the peripheral distribution of the nerves. The fact has of late years been, in a measure, lost sight of that general anæsthetics do as a matter of fact not only annul perception of pain but protect the brain from the hypothetical " bombardment " of the nervous tissue by noxious centre seeking stimuli. He also made the pertinent observation that in order to obtain peripheral analgesia an evenly distributed partial blood saturation by the anæsthetic is requisite. Thus a slowly but

evenly induced narcosis is essential to this end. Waller's classical work on the effects of anæsthetics upon detached nerves has now bridged the gap in our knowledge, and has taught us that the analgesic effect arises from, first, a retardation and then an annulling of the conductivity of the nerve cylinders. Further, Snow points out that both the brain anæsthesia and the loss of common sensation vary in their time of onset in different types of individuals. In stout persons the time is short, in intellectuals it is the longest, while in heavy drinkers, although the tardily arrived at brain anæsthesia may be profound yet the lower reflexes would appear to persist, as such persons move their limbs and execute what appear to be protective reflexes even in deep narcosis, in much the same manner as in the case of the brainless frog. Snow does not deal with reflexes, but he arrives at conclusions given above; nor did he know of the avidity which lipoids possess for chloroform and ether.

Two of the most interesting and valuable sections in his book are those dealing respectively (1) with fatalities, real or assumed, and (2) with the symptoms of such fatalities. He dismisses the notion that there is an idiosyncrasy predisposing to chloroform accidents. He believes that fear, incomplete anæsthesia, that is, too light a grade of narcosis, are dangerous. The sudden deaths he imputes to high percentages stopping the heart and causing syncope. Wakley and the Emulation Society of Paris attempted to prove that the respiration always caused death, and the heart always failed subsequently; but Snow shrewdly points out that their experiments were faulty, as no attempt was made to paralyse the heart by overdosage by high percentages. This error was repeated in the more recent experiments of the Hyderabad Commission, a fact which the present writer pointed out at the time of the publication of the Report. Further, Snow discusses with great care and acumen the effect of chloroform when given to persons suffering from various diseases. His well-known dictum may be quoted, as it remains a guide to anæsthetists to-day. "If," he writes, "a patient's condition is such that he can be subjected to operative procedure, he can certainly be anæsthetised without undue risk." In this connexion we may recall his experience of hysterics and epileptics; the former he

found usually had a fit in the second, the latter in the third degree of narcosis. As regards epileptics, the present writer's experience goes to show that in the case of Jacksonian epilepsy the fit, which practically always occurs during induction, generally developes in the second degree, especially if the excitement is marked. Snow suggests that the administration of chloroform to malingerers who behave like an epileptic proves a useful test.

There is one important point in which the practice advocated and adopted by Snow differs from the view commonly held by modern-day anæsthetists. He could see no danger in the sitting posture, and he quotes over nine hundred cases in which he so placed his patients. But this was before the days of the radical operation of tonsillectomy and submucous resections. Whether Snow, had he our knowledge of the capillary circulation, and Leonard Hill's work on the "abdominal pool," would have adhered to the views he enunciates on this point in his book is, we think, at least doubtful.

It would be tedious, in a paper of this kind, to labour the matter further, but it will probably explain many of the discrepancies of Snow's dicta and the teaching of to-day if we quote his directions about administration, since they show in vivid contrast the method he adopted and the methods which the modern surgeon requires to be pursued by the modern anæsthetist. Snow writes: "The first application of chloroform often suffices for an operation, if it is of short duration, without repeating the inhalation. In a few cases the patient remains insensible to the knife for three minutes after the inhalation is left off, but this is an exception; and one cannot at all events make sure of this prolonged effect of chloroform, without producing a deeper state of narcotism than is desirable. More usually, if the operation lasts more than a minute or two it is necessary to repeat the inhalation; it is, indeed, generally desirable to let the patient have a few inspirations of air charged with chloroform vapour every half minute or so whilst the operation continues in order to keep up the insensibility." "In the greater number of operations, however, it is better to wait till there is some sign of sensibility, such as a slight cry or tendency to flinch, before the inhalation

is resumed; and then a few inspirations of well-diluted vapour made the patient quiet again."

In spite of the obvious difference between the exigencies of surgery in Snow's time and our own, the writer is convinced that Snow's work is still worth careful study and consideration. His analysis of fatal cases, his experiments undertaken to explain the mechanism of death under chloroform are admirable in their clarity and accuracy of reasoning. The fear of chloroform so prevalent to-day is largely due to our ignorance of its action and our neglect of the more accurate methods of employing it, and in this sense is deplorable. To study Snow's work and follow it by studying the more recent experimental research would, the writer believes, prove most helpful to those who, not being experts, have relegated chloroform to the limbo of bogeydom and so lost the aid of a most valuable asset to their anæsthetic armamentarium.

In keeping with the plans for the readjustment of the medical profession in America into regional groupings, it is the intention of the Reorganization Meeting of the Associated Anæsthetists of the United States and Canada to build up a strong parent organization, and thus realign the Regional Societies.

The Third Annual Congress will be held at Chicago, June 9-14, during the Medical Association Week, the Anæsthesia Session being a part of the Section of Miscellaneous Topics.

The five Regional Societies—Canadian, Eastern, Southern, Mid-Western and Pacific Coast—will be represented by delegates who will be empowered to form plans for the new organization which is to be known as the Associated Anæsthetists, and which is to be governed by a House of Delegates to consist of two or more delegates from each regional society, as well as officers and executive staff.

The Associated Anæsthetists will undertake the standardization of hospital anæsthesia service, will encourage graduate and post-graduate instruction, and, if thought advisable, develop a College of Anæsthesia.

If these plans are agreed to each anæsthetist member will be called upon to contribute a total of about four pounds annually in subscriptions, viz., to the Associated Anæsthetists, to his Regional Society, and to the Research Society.

If this arrangement is carried out it will place the specialty of anæsthesia in America on a solid basis. It will mean that on all matters of importance united action can be taken by an executive able and authorized to speak for the united membership of the United States and Canada.

MODERN DEVELOPMENTS IN ANÆSTHESIA.

By S. R. Wilson, M.B., B.S., M.Sc., F.R.C.S.E.

(Post Graduate Lecture, Manchester Royal Infirmary, Dec. 14, 1923.)

IT has been said by Bernard Shaw "that anæsthesia spares us nothing but the actual cut"; but whilst this may have been true in the past it no longer applies to the up-to-date anæsthetist, who is not simply concerned with the production of unconsciousness but with the comfort, safety and ultimate recovery of the patient, in addition to the facilitation of the special surgical procedure. Such a standard can only be attained by careful preliminary preparation, by thorough examination of the patient beforehand, and by a scientific knowledge of the immediate and remote effects of the anæsthetics concerned, both in health and disease.

In connexion with the investigation of the patient's condition it is my hope that we shall in future gain more and more help from co-operation with the physician than hitherto. Unfortunately, many medical opinions have not been too helpful in the past, and the reason of this is not far to seek. Too often he contents himself with saying, "whether an anæsthetic may or may not be given," an attitude which gives us no real information and frequently ties our hands considerably, for the determination to administer an anæsthetic and the precise procedure to be adopted is entirely outside his sphere. He should content himself with a full report of the patient's medical condition and leave the rest to the anæsthetist, who is only too pleased to have the benefit and assistance of his skilled medical examination. The influence of modern scientific work on anæsthetic procedure may be conveniently discussed under the following headings: (1) The preparation of the patient; (2) anæsthetic prognosis; (3) the period of induction; (4) the period of maintenance; (5) the period of recovery; (6) post-anæsthetic complications.

The Preparation of the Patient.

This branch of the subject is of equal interest to the surgeon, anæsthetist and practitioner, and one frequently gets inquiries as to the preparation one prefers.

The chief modern development in this respect have been directed towards the reduction of starvation and excessive purgation, for these procedures tend to produce mental distress and exhaustion of the patient. Further, they actually predispose to acidosis, shock, and septic infection.

Perhaps the simplest way of dealing with this aspect of the subject will be to define one's routine procedure in an adult about to undergo a surgical operation of average severity. It is desirable that the patient should be admitted into the home or hospital at least two nights before the operation. From the very first strict attention is given to the antiseptic treatment of the mouth. The patient is instructed to rinse the mouth before and after food with sodium phenate or Listerine, and to thoroughly cleanse the teeth, whether natural or artificial. In operations about the mouth the services of a dentist may have to be requisitioned. This procedure lessens the liability of pulmonary and parotid infection, minimizes the risks of alimentary intoxications, and gives the patient something to do. As regards aperients, the time-honoured ones are still the favourites, viz., castor oil (up to 1 oz.) and compound liquorice powder (up to 2 drachms). The time of administration is, however, a point of considerable importance, and the most favourable period is about 2—3 a.m. of the night but one before operation. This ensures minimum disturbance of the patient's rest, for at worst it splits the patient's rest into two four-hourly periods, and the effect of the drug takes place in the daytime, and is not so upsetting as at night. If the aperient acts satisfactorily (say three times) no further preparation is necessary in this respect, but if there is any doubt a simple enema is given at 6 p.m. of the evening before operation. This should be administered with a tube and funnel, and not with a Higginson's syringe. In some cases enemas have a disturbing effect on the patient's condition, and may cause considerable shock. On occasion one has had to postpone operations temporarily on this account, and one is inclined to believe that it is forcible distension of the colon that is

responsible for the effect. With the preparation under discussion enema rashes seem to have practically disappeared. As regards diet, all foods given to the patient are sterilized. This does not involve any complex or elaborate preparation, but a selection of those foods which in virtue of their natural modes of cooking are rendered sterile, viz., lightly-boiled eggs, soups, steamed fish, toast and milk puddings. Some prefer to exclude from the diet all albumins of animal origin and maintain that this avoids post-anæsthetic vomiting and lessens the work thrown on the liver, but with the diet recommended after-vomiting is very rare. The meals are given at the usual time, the last meal on the day before operation being at 7 p.m. and consisting of soup and toast. Some anæsthetists advocate milk, but personally I prefer soup, for in nervous patients I have known clots to be vomited 24 hours after milk has been taken. The final meal is given four hours before the time of operation, but this period is reduced to 2—3 hours in the case of children. This last meal also consists of soup and toast. In the case of children, glucose is administered in the form of barley sugar, raisin tea or sweetened liquids practically up to the time of operation. Some advocate glucose in adults, but this is a point of lesser importance, and may as a rule be omitted. The patient is encouraged to drink as much fluid as possible, and a jug of water is left at the bedside. In rectal cases an additional procedure is advisable and will avoid those distressing experiences which one so often saw in the past when surgeons operated on this part, an incident which caused unmerited blame to fall upon the nursing staff, for the excessive purgation of those days frequently led to the production of diarrhœa. In this class of case, one hour after the administration of the evening enema, five minims of Tinct. Opii in one drachm of water are given, and this is repeated four-hourly until three doses have been administered. The opium produces a state of quiescence in the bowels, which have been fairly well cleared by the earlier procedure, and interruption of the surgeon's work and contamination of the field of operation are avoided. Finally, one would like to draw attention to the patient's clothing as regards preparation for operation. The lowering of body temperature is undoubtedly an important factor in the

production of surgical shock, and for some time past surgeons have been in the habit of wrapping up the patient's limbs in cotton wool as a preliminary to severe operations. The cause of this lowering of temperature is partly the disturbance of the thermogenic centres by the anæsthetic, but the most important factor is the evaporation of sweat. It is not the secretion but the subsequent evaporation of the sweat which matters most for the latent heat of evaporation required is largely abstracted from the body, chilling the latter. This is easily noticeable about the head and neck in severe cases, and in the past one has been in the habit of packing round the head and neck with gamgee tissue. This method is, however, clumsy, extravagant in wool, and leaves the patient unprovided for after returning to bed, where the same factors still hold good. I would remind you that the greatest accumulations of sweat glands are on the palms of the hands, the soles of the feet and about the face; parts largely ignored in former preparations. With these objects in view, I have devised an operation suit, and the making of the same has been carried out by the Nursing Staff of the Elmfield Nursing Home, Manchester. The patient is clothed in a woollen vest and pyjamas. The head and neck are enclosed in a flannel helmet, which is adjustable, and can cover up all parts save those actually covered by the anæsthetic mask. A slit in the helmet will enable one to observe the condition of the ear and feel the pulse. The upper extremities from wrist to shoulder are enclosed in special flannel sleeves, fastened with tapes, and thick woollen gloves enclose the hands and extend over the flannel sleeves to the elbow. Woollen stockings are worn over the pyjamas and extend almost to the groins (illustration). The suit is especially serviceable in abdominal operations. It has been in use for some time with most gratifying results, the patient's skin being devoid of any suspicion of clamminess and pallor which were formerly often observed in varying degrees. The suit is retained when the patient returns to bed and prevents loss of heat from the body in the recovery stage.

Before leaving the question of preparation of the patient one must refer to the problem of the preliminary administration of alkaloidal drugs.

Operation Suit. (Wilson.)

Preliminary Medication.

Of late years the general tendency has been to rely on atropine alone as a routine procedure, except in the case of nitrous oxide and oxygen administrations. The advantages of atropine are indisputable. It is a respiratory stimulant, and in virtue of its power of inhibiting the buccal and bronchial secretions lessens after-sickness, minimises the risks of pulmonary complications and facilitates a free air-way, for, in addition to the diminished secretion, it produces bronchial relaxation. By paralyzing the vague nerve-endings in the heart it lessens the danger of reflex syncope from too strong a vapour or from surgical manipulation. It diminishes shock, and, by lessening the secretion of sweat, removes an important cause of lowering of body temperature during surgical operations. The diminution of secretion which it produces renders it of special value in operations on the upper air-passages, and Mr. Musgrave Woodman informs me that he gives two preliminary injections of the drug for this purpose. The chief objection to atropine is the dryness of the mouth and thirst which results, but this can be minimized if the injection be delayed until 20—30 minutes before administration. The patient may be allowed to rinse out the mouth with water beforehand provided none is swallowed. After-thirst is of little consequence, for most surgeons allow the patients to drink freely on recovery from the anæsthetic. Levy states that atropine carries with it an increased risk of ventricular fibrillation, but I do not think that clinical experience affords evidence of this.

Further experiments on animals are desirable before making a definite statement on this question.

I abandoned morphine as a routine procedure about 15 years ago, partly on account of the respiratory depression which it causes. The induction period, though quiet, tends to be delayed on account of the respiratory exchange being diminished about 50 per cent. unless a closed system of administration be employed. Cyanosis is very prone to occur, and muscular relaxation is not usually so complete. Oxygen ought certainly to be at hand if morphine is used. Fluid in the throat is not so easily spontaneously dislodged, and the delay in the recovery period in getting rid of secretions and

dissolved anæsthetic leads to prolongation of sickness and increased risk of pulmonary infection. A further objection to morphine is that it masks the pupillary reactions, whereas atropine in ordinary doses does not. At the same time there are certain cases in which the preliminary administration of morphine is of extreme value.

(1) Before administering nitrous oxide for small surgical operations, such as whitlows and cellulitis. In these cases it abolishes the reflex movements which are prone to occur on incision into acutely inflamed parts, and saves the patient the immediate severe after-pain.

(2) When nitrous oxide and oxygen are used for major surgical operations. For this purpose Boyle recommends Hyoscine Compound, A. or B. (Burroughs-Welcome) half an hour before administration, except in the case of children.

(3) In cases where one desires to reduce the amount of anæsthetic used, as in diabetes and acidosis.

(4) Whenever excessive activity of the sympathetic system is present. This occurs in exophthalmic goitre and in patients of the sympathetico-tonic type, who manifest considerable psychic shock.

The action of morphine in paralyzing sympathetic ganglia is of the utmost importance in these conditions, and has not, in my opinion, been sufficiently realized. To obtain the full benefit of the drug it should, however, be given in small doses over a fairly long period. In exophthalmic goitre I frequently give three or four doses of $\frac{1}{8}$—$\frac{1}{6}$ grain at four-hourly intervals, the last being given half an hour before operation and combined with atropine.

In cases where limitation of anæsthetic is required the development of synergistic anæsthesia is likely to prove of great value, and I have resorted to it with satisfaction in bad cases of hyper-thyroidism. For interesting applications of this method in childbirth one must refer to papers by Gwathmey and others in the first two issues of the *British Journal of Anæsthesia.*

Anæsthetic Prognosis.

Those engaged in surgical practice are only too familiar

with a certain adage, which is not infrequently repeated in lay circles with a certain amount of derision, "the operation was successful, but the patient died." The statement is, to say the least unfortunate, and the underlying sarcasm deserved, for the true measure of surgical success lies in the cure, or at any rate in the relief of the patient. Whilst, in desperate cases, excessive risks are necessary, in others a careful estimate of the operative risk should be made. Mere collections of post-operative mortality figures give no accurate estimate of the individual risk incurred. In such an investigation the anæsthetist is intimately concerned for the selection of the most suitable form of anæsthesia, the estimation of the amount of surgical manipulation which the patient can stand and ultimately survive, and the avoidance of deleterious or dangerous post-anæsthetic effects are his special duty. It is in this direction that the greatest advances in general anæsthesia are to be made.

Whilst in no way decrying the value of an ordinary clinical examination of the patient, I wish to draw attention more particularly to those observations which are of special value to the anæsthetist in this regard, concerning which we rarely receive information from the physician.

1. *The condition of the blood.* The existence of anæmia is of particular import, for such patients will not stand much loss of blood or profound lowering of blood-pressure. Further, a fatty condition of the heart muscle probably co-exists. Whilst as a rule a general inspection will suffice, in pronounced cases more accurate observations are desirable, and either a hæmoglobinometer or Tallquist's hæmoglobin scale should be resorted to. If the hæmoglobin percentage is 60 per cent. or less chloroform is extremely dangerous and should be avoided. A closed method of administration (gas and oxygen with ether) is to be preferred, for the retained carbon dioxide is of great value in maintaining the blood pressure.

Chloroform also increases the fragility of the red blood corpuscles, and should be excluded where this condition already exists, as in acholuric jaundice.

A knowledge of the blood coagulation time is also of great value at times, and in my own experience during the past few months relatives have reported that the patient is a hæmophilic

after the administration had commenced and whilst the surgeon was preparing his hands. One was able in a few minutes to recommend the surgeon to proceed and incidentally remove future anxiety from the relatives' minds. Whilst ten methods of determining coagulation time are available, the most convenient ones in surgical work are the "glass plate method," Dale and Laidlaw's shot coagulator, and Gibb's platinum loop. The necessary appliances occupy very little space in one's bag, and even if absent a rough estimate may be made with the polished glass of a hand-mirror and the blunt end of a needle. If a thread of fibrin can be drawn up out of a drop of blood on the glass with the needle within ten minutes one may proceed without anxiety.

2. *The cardio-vascular system.* The estimation of blood pressure affords the most valuable information in relation to operative prognosis. It enables one to determine the condition of the cardiac muscle and indicates the capacity of the patient to withstand hæmorrhage, shock and surgical manipulation. It also intimately modifies the choice of the anæsthetic.

Both systolic and diastolic pressures should be determined, the difference between the two giving the pulse pressure. Moot's rule is most valuable in this respect:

$$\frac{\text{Pulse pressure}}{\text{Diastolic pressure}} \times 100.$$

If the resulting figure is between 25—75 per cent. the case is favourable. If outside either of these figures the case is unfavourable.

McKesson has also made an observation of the utmost importance as regards the relationship of blood pressure to operative mortality. Although it refers to the period of maintenance of anæsthesia it is convenient to mention it here. He states "That after half an hour of sustained low blood pressure and rapid pulse almost every patient succumbs, either shortly or within three days of surgical shock or cardiac exhaustion." It is the anæsthetist's duty to observe these points and to draw the surgeon's attention to the necessity of acceleration of the operation. If the operation is completed within the half hour recovery usually occurs. Another simple test of great value is the "breath-holding test." The patient is instructed to take three deep breaths and the last one is held.

If the breath cannot be held 40 seconds further investigation of the cardio-vascular system is necessary. At the same time it should be borne in mind that a similar state occurs in acidosis. Further tests of cardiac efficiency have been devised from a study of the effects of exercise on the circulatory and respiratory systems.

Cashman's test. Normal exercise raises both systolic and diastolic pressure, but the former is increased to a greater extent, with the result that the pulse pressure is increased. A fall of pulse pressure implies poor resistance in the circulatory system.

Goodall and Lambert's test. The pulse, systolic blood pressure and respirations are taken before and after standard exercises. According to results observed they classify the responses into four groups:—

Group 1. Good. All the reactions are increased by exercise, but all return to normal in three minutes.

Group 2. Fair. The return to normal is not so quick, but occurs on normal lines.

Group 3. Bad. The blood pressure is not raised, but pulse and respiration are increased.

Group 4. Very bad. The blood pressure falls, but pulse and respiration are increased.

Whilst these exercise tests are of great value, the presence of serious illness in the patient may render the standard exercises undesirable. Under such conditions information of value may possibly be obtained by the use of the manometer test. My attention was originally drawn to this by one of my colleagues in the Physiology Department, Dr. McSwiney. He and Hambly used a modification of Flack's test to study the influence of the manometer test in relation to muscular exercise. The pulse-rate is taken for one minute; a column of mercury is then raised by expiration to a height of 40 mm., and held there for twenty seconds. The pulse-rate is then taken for another minute. After muscular work there is on an average a fall of 10 per cent. in the pulse-rate. I have tried to adapt the test to surgical work without any preliminary exercise. The necessary apparatus is easily improvised from a mouthpiece of glass tubing connected with rubber tubing to the aneroid of a sphygmomanometer. A marked fall in pulse-

rate or inability to sustain the test is suggestive of cardiac insufficiency. In feeble women or in debilitated subjects a height of 20—30 mm. is sufficient. More extensive observations are desirable before one can estimate its precise value. In cases of actual cardiac disease and in exophthalmic goitre electrocardiograph and polygraph tracings are of value.

Cases of cardiac disease—even auricular fibrillation—usually do very well if struggling be avoided and an appropriate anæsthetic be selected, viz., open ether and oxygen. A preliminary course of treatment with digitalis is of the utmost value.

3. Metabolic tests. The basal metabolic rate is an observation of some value in cases of hyperthyroidism. It is determined by the Sanborn-Benedict apparatus. If the oxygen consumption is over 150 (100 being taken as normal) the condition is not very favourable. Of late Crile has expressed some doubt as to the value of this observation, but I am inclined to think that it affords evidence, at any rate, of the effectiveness or otherwise of the preliminary medical treatment adopted. In the Mayo Clinic iodine in the form of Lugol solution is administered in 10 m. doses daily as a preliminary, and is said to reduce the palpitation, tremors and nervousness, in addition to lowering basal metabolism. Lugol solution is the Liquor Iodi Co. of the U.S.A. Pharmacopœia, and consists of iodine 5 parts, iodide of potash 10 parts, and water to 100 parts.

Under the heading of metabolic tests one may conveniently turn to the question of hepatic, renal and pancreatic insufficiency. The condition of these organs is of great importance to the anæsthetist, as it markedly influences the choice of the anæsthetic, and likewise the depth and duration of the anæsthesia. It would appear that the action of the various general anæsthetics on these organs is proportional to their lipoid solvent power. Chloroform is the most damaging in this respect, whilst nitrous oxide and oxygen is the least toxic. The anæsthetic must be reduced to a minimum and anoxæmia avoided.

The determination of hepatic insufficiency presents considerable difficulties partly on account of the numerous functions which the liver subserves, partly on account of the

interdependence on other organs, particularly the kidneys. A personal experience will emphasize the importance of this close association of the two organs. Some months ago I was asked to administer an anæsthetic in a case of suspected gall-stones. Examination of the urine revealed a large quantity of albumin. A physician was called in and diagnosed organic disease of the kidney. Owing to persistent pain an exploratory operation was performed and gall-stones removed. After 48 hours the albumin entirely disappeared. In this case the albuminuria was a sequel of an hepatic toxæmia. Subsequent observation has shown that such an association is not uncommon. Whilst considerable attention has been given to this subject of late, the precise value of the various tests are still somewhat uncertain. The best tests up to now would seem to be: the ratio of urea nitrogen to total nitrogen, the camphor test, Van der Bergh's test, the lævulose test, and the lipase test. Useful information might be obtained by performing these tests before and after a general anæsthetic.

The estimation of the blood urea throws light both on the hepatic and renal condition. Normally its amount is 20—40 mmg. per 100 cc. If it exceeds 90—100 mmg. the prognosis becomes unfavourable.

The urea concentration test is of value if taken into consideration with other factors, especially the blood urea. The relationship desired may be expressed thus :—

$$\frac{\text{Mmgs. of urea per 100 cc. urine.}}{\text{Mmgs. of urea per 100 cc. blood.}}$$

If the resulting figure is between 60 and 80 the outlook is favourable.

An ordinary routine examination of the urine should always be made, the most essential tests being for albumin, sugar, acetone and di-acetic acid. If albumin is present further investigation as to its cause must be made. When sugar is found the case should be placed in the hands of a physician for investigation of the nature of the glycosuria. If the condition is one of true diabetes operation should be postponed until suitable dietetic and insulin treatment have been established. The importance of acetone and di-acetic acid and other special tests bearing on this subject will be dealt with when considering post-anæsthetic toxæmias.

SOME RESULTS OF OPERATIONS UPON THE CIRCULATION: THEIR SIGNIFICANCE AND TREATMENT.*

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THE more recent extension of laboratory examinations and more thorough physical examinations made before operations is a great step toward the individualization of treatment. It is a movement in the right direction which needs to be still further developed in the best interests of surgery and the patient. We cannot know too much of the patient's physical condition. It furnishes the necessary basis for interpreting the reactions observed during and after operations, and renders surgical intervention safer and more definite.

The surgical team is rapidly coming to be made up of a group of co-operating specialists whose members are prepared to apply the discoveries of the various medical sciences to the patient at operation. The surgeon in particular needs to encourage and develop his associates so that they may better perform important functions which he is unable to carry out during the operation. The only way to develop the anæsthetist into an internist with a surgical "slant" is to increase his responsibilities and to demand more definite answers to that common question: "What is the patient's condition?"

Laboratory work and physical examinations lose much of their force if similar and accurate observations are not followed through the operations. In the average clinic this is not being done as well as it might. Not infrequently circulatory reactions begin on the table which, if neglected when they might be corrected, lead to the destruction of the patient and to the discredit of surgery. The blood pressure and pulse furnish some of the desired information. Neuhof,[3] in his

* Read before a joint session of the Chicago Medical Society and the Chicago Society of Anæsthetists, March 12th, 1924.

new book on "The Heart," puts it aptly when he says: "The introduction and use of the sphygmomanometer have shown that the estimation of the blood pressure by radial palpation alone is erroneous and untrustworthy."

The circulation is a delicately balanced mechanism which reflects the immediate condition of the patient in a most exact manner. A continued study of its reactions soon convinces the observer of the truth of this statement. The variety of responses is large, and it requires experience and study to interpret them, but every anæsthetist should master what seems to me to be one of his most important duties.

To make the work practical and of immediate as well as of educational value, a graphic record of the pulse-rate, the systolic and diastolic blood pressures, the respiration and notes regarding pertinent factors influencing the patient, should be made during the operation at frequent intervals. The official anæsthetic chart* of the National Anæsthesia Research Society embodies the minimum requirements.

Fortunately, these observations and records may be made by the anæsthetist without much inconvenience. With this information the anæsthetist will learn more of the direct effects of his technique and what anæsthetics are best. The surgeon also will learn by a review of these records that certain methods of operating under certain conditions are good or bad. In the end, both are benefited with the patient.

Equipment.

The auscultatory method of taking blood pressures is preferred as being more accurate and more convenient in surgical work. Mercurial instruments may be used, but the aneroid type, either large or small, is more practical in the operating room. The cuff is applied to either arm, preferably the right. It should be smoothly wrapped about the arm and the flaps secured with a safety pin. It is left in place throughout the operation. The stethescope should be a Bowles or similar flat-belled diaphragm type, applied just below the cuff and above the elbow, squarely over the artery.

* Arrangements are now being made to place this chart on sale in Great Britain.—(Editor.)

It is held in this position by means of an ordinary elastic web, three-fourths of an inch wide, with a suitable buckle for adjusting it. Inelastic material, such as leather, etc., is an unsatisfactory substitute for elastic, as it does not maintain the position of the stethescope bell with gentle pressure. A rubber tube about two feet long, connecting the bell with the ear-pieces, completes the equipment.

A determination of the pulse-rate, blood pressures and respiratory rate should be made just before beginning narcosis. This reading gives much information regarding the effects of fear, the effects of pre-anæsthetic narcotics in controlling this factor as well as serving as a criterion for comparison with subsequent readings.

After narcosis has been satisfactorily established, but before the surgeon begins, another set of readings gives the immediate effects of the anæsthetic and serves as the operative normal which it is desired to maintain or to improve if incompatible with the well-being of the patient.

Circulatory Depression.

The outstanding factors in an operation are: (1) the condition of the patient, (2) the trauma of surgery, (3) the loss of blood and other fluids, (4) the protective or destructive effects of anæsthesia. One or all may be factors of depression.

While it may be assumed in the normal case that the circulation is at its optimum before an operation, and that practically *any* change in pulse and blood pressures indicates some measure of depression, there are some abnormal conditions which are actually improved during narcosis. The latter is, however, the exception, and is usually the result of well-directed attention to details in the operative and anæsthetic procedures, and not accidental.

In previous papers [1] I have classified circulatory depression into three degrees, roughly corresponding with the clinical results obtained:—

The First Degree comprises an increase of not more than 15 per cent. in the pulse-rate without an increase of blood pressures, or a 10 per cent. decrease in blood pressures without an increase in pulse-rate.

The Second Degree comprises an increase in pulse-rate of about 25 per cent. associated with a decrease in blood pressures of from 10 to 25 per cent., or equivalent combinations.

The Third Degree comprises a pulse-rate of 100 and progressively increasing; associated with a systolic of 80 mm. or less, a diastolic of 60 mm. or less and a pulse pressure of 20 mm. or less, all progressively falling.

Third degree depression is usually fatal if allowed to continue during an operation for a period longer than twenty to thirty minutes without successful treatment. The patient may live for minutes or as much as seventy-two hours in this condition of shock, depending upon the vital resistance and previous condition of the heart muscle. When death occurs, it is one of cardiac exhaustion, complicated by incomplete oxygenation and nutrition.

It is evident that both the blood pressure and the pulse-rate are essential in evaluating the circulatory situation, and that shock, which is represented by the third degree, is characterized by low pressures and tachycardia. Low pressures are more compatible with life than tachycardia, but their combination spells disaster sooner or later, unless effective treatment is applied promptly.

In checking up the prognosis of third degree depression, Miller, in 1,000 cases, found that those who were in third degree for more than 25 minutes showed a mortality rate of 69.23 per cent.[4]

Tachycardia.

The tachycardia of fear is best prevented by appropriate doses of morphine with or without hyoscin, but without atropin. Tachycardia is objectionable before, during and following operations, as it exhausts the heart, shortens its period of rest, and reduces the regeneration of the heart muscle.

During an operation, tachycardia is usually preceded by a temporary fall in blood pressures, sometimes for a considerable period before the pulse-rate increases. The increase of pulse-rate in these cases, when it does begin, is usually abrupt, due to some new manœuvre of the surgeon, a spurt from a relatively large vessel, temporary obstruction of respiration,

or some error in anæsthesia. Once the pulse-rate is elevated under these conditions it rarely returns to its old rate until after the packs are removed and the abdomen is closed. With the increased pulse-rate the blood pressures ordinarily increase, but not in their normal ratios. If the error is shortly repeated a further increase in pulse-rate may take place with little increase in blood pressure, while if the offence is too great the blood pressures actually fall while the pulse-rate climbs to the status of tachycardia. Under such conditions the heart is probably not at fault, but is making an effort to maintain an efficient circulation after some disturbance in the distribution of the blood has taken place, which lowers the blood pressures. The systolic falls out of proportion to the diastolic, often leaving a small pulse pressure. In other cases the pulse pressure is relatively increased. These are the more favourable.

Myocardial Defects.

Cardiac arrhythmias affecting the rate are readily detected in the pulse. The *functional* types often disappear during a carefully conducted narcosis. The circulation in these cases is usually good, but sometimes improves. The *organic* types either do not improve or are made worse.

Pulsus alternans, which is an arrhythmia not of rate necessarily, but of weak and strong heart contractions characterized by alternating small and large pulse pressures is not only readily detected with the sphygmomanometer, but is subject to actual measurement. Arrhythmias, particularly of this type, require close watching, because, as pointed out by Herrick, Lyons, Hawthorne and MacKenzie, they indicate "a serious impairment of the muscular organisms of the heart, which has lost the capacity to respond with maximum contraction to every stimulus—the contracting capacity is diminished."[2] It is second in frequency of the cardiac arrhythmias, and of particular importance in surgery as indicating myocardial defects.

The patient may show no arrhythmia before operation, but under the stress of surgery pulsus alternans occasionally develops, showing that the heart muscle is unable to adequately respond to the extra labour. It is encountered

more frequently in hypertension, arteriosclerosis, myocarditis and nephritis. In surgical cases, I have found it also in cholæmia, eclampsia, anæmia and uræmia—some of the cases which are regarded as dangerous risks. These cases promptly succumb to a fall in blood pressures and increased pulse-rates, amounting to what I have described as third degree depression if untreated.

If the condition is recognized before operation, digitalis is indicated, even though the pulse-rate is not rapid, and when it develops during operation some digitalis preparation should be administered intravenously. The operation should proceed with the minimum of trauma under light narcosis. Morphine in sufficient doses to produce its physiological effects is desirable, preferably before, but may also be used with good results during, the operation.

Pulsus alternans must be differentiated from sinus arrhythmia, which causes a rhythmical variation in the systolic and diastolic blood pressures, associated with corresponding changes of pulse-rates caused by respiration. And, while it is generally held that sinus arrhythmia is a physiological process, it is rendered more apparent in operations than normal owing to the greater difference in pulmonary air pressures than normal. There is little danger, however, of confusing it with pulsus alternans on account of its synchronism with the respiration.

Myocardial defects are more serious than valvular disease of the heart if compensated. The crux of the matter is, whether or not the circulatory mechanism is able to maintain a proper distribution of blood without cardiac exhaustion during the relatively short period of surgical intervention.

A study of the case at the moment will show how far we may go with surgery. If the case is border-line before beginning the operation, the test of surgery only will tell how the circulation will react.

Patients with valvular defects which are grossly complicated with myocardial weakness require most careful anæsthesia and surgery to avoid disaster. All valvular cases may be regarded with suspicion until the test of surgery shows the heart muscle to contain the essential reserve power to compensate for any ordinary disturbance of blood distribution.

Treatment of Third Degree.

We formerly lost more cases from shock than we do now, because we had about reached the conclusion that no treatment except prophylaxis, which in many cases is impossible, was really effective. I had tried all of the drugs recommended, including saline and gum solutions, with quite unsatisfactory results.

More recently I have saved most of those who would have died in third degree with sterile physiological salt solution, given intravenously, employing such a quantity, whether it be 500 cc. or 5000 cc., as is necessary *to restore the systolic pressure to within 10 per cent. of its normal reading*, and repeating it by the intravenous route at any time shock reasserts itself.

It is important that the saline be isotonic, that it be given sufficiently rapid (up to 100 cc. per minute) to build up the systolic blood pressure progressively, that it is administered at body temperature, and that it is given as soon as possible after third degree has become established.

In the average hospital too much time is lost in the preparation of this equipment. Shock drill should be more important in a hospital than fire drill. The equipment should be kept in readiness and in good condition for prompt service, as delays cause preventable loss of life.

Two errors in the treatment of third degree depression are commonly made: (1) The condition is not recognized until it is so well advanced that the vicious cycle of muscular exhaustion plus insufficient nutrition caused by rapid systoles and low blood pressures is fairly established; (2) when saline is used it is usually administered either via the rectum or subcutaneously, neither of which routes are often successful; or, if given intravenously, it is not run in fast enough to overtake the falling blood pressure, or it is given in an insufficient quantity.

It would be better if the quantity were not measured by those who fear that too much might be given, since no quantity short of enough to fairly restore the blood pressures will save the life. The slower the solution runs in the more is required to restore the blood pressure.

The diastolic is not usually increased as promptly or as

much relatively as the systolic. In fact, the diastolic commonly is increased very little until after the systolic has been up for some time showing that muscular tonus in the peripheral vessels is slow to return.

For some time after saline the pulse pressure is relatively very large. (Normally the pulse pressure is half the diastolic pressure expressed in millimetres with an allowable 10 per cent. variation above or below without indicating pathology.) Gradually the pulse pressure approaches the patient's normal, which is ordinarily due in these cases, to an increased diastolic with some fall in systolic.

I have never seen a heart dilated by giving too much saline intravenously, although I have given over 5000 cc. in two and a half hours in one case. On the other hand, I have seen several deaths in years past because too little saline was given, which I now believe were preventable.

Where the saline is used in large amounts there are occasionally some œdema of the lower eyelids. But this is gone in a few hours after shock is corrected. The kidneys act very freely during these few hours, while eliminating the excess of fluid, which necessitates more frequent catheterization of the bladder.

The patient should, of course, be kept warm, and the causes of shock should be removed as early as possible.

If shock develops *after* the operation from pain or other causes, the prompt use of intravenous saline, as above described, together with morphine or other indicated drugs, gives more favourable results than I have seen by any other method.

Some advantages of intravenous physiological saline are:

1. It may be given in large amounts without "reactions."
2. It is readily eliminated by the kidneys after it has accomplished its purpose of mobilizing the blood from stasis in the splanchnic area, and re-establishing circulatory balance.
3. It may be repeated without reaction.
4. It lowers the viscosity of the blood in shock.
5. It may be charged with oxygen and administered very rapidly if necessary.
6. It is available on short notice, which is its principal advantage over blood transfusion.

7. It is safer than blood transfusion in ordinary shock unless there has been a great hæmorrhage when whole blood is probably better if carefully typed.

Conclusions.

1. The anæsthetist should know the circulatory conditions of the patient at all times.

2. The pulse and blood pressure ratios are pre-requisites for the interpretation of the circulation.

3. Circulatory depression varies in intensity, as shown by the pulse-blood pressure ratios. Third degree is fatal in 69 per cent. of cases if untreated.

4. Most cases of surgical shock may be saved by the prompt intravenous administration of physiological saline in sufficient quantity to restore the systolic to within 10 per cent. of the patient's normal.

5. It is desirable and practicable for the anæsthetist to make a record of the pulse, respiration, blood pressures, etc., during the operation.

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Professor Dennis E. Jackson of the University of Cincinatti Medical College has been presented with a Scroll of Recognition by the National Anæsthesia Research Society for his extensive investigations in the pharmacology of anæsthetics.

In conjunction with, and at the suggestion of, Dr. F. H. McMechan, editor of "Current Researches in Anæsthesia and Analgesia," the *British Journal of Anæsthesia* will co-operate with The National Anæsthesia Research Society of the United States in providing a list of anæsthetists in the British Empire to be included in the next edition of the Directory of Anæsthetists published by that Society. This will make the directory international in character, and will thus cover the English speaking world.

CARDIAC MASSAGE. *

By A. G. Levy, M.D., M.R.C.P.,
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I THINK I can explain the principles of cardiac massage without inflicting a long lecture, for it is *au fond* a simple enough matter.

Many of you remember in your early physiological training the scheme set up to represent the circulation,—rubber tubes to represent the arteries and a rubber ball with valves to represent the heart. By squeezing the ball fluid is made to circulate in the tubes. This is exactly the procedure in so-called cardiac massage. It is not massage at all in the ordinary sense of the word, but it is a rhythmic compression of the heart in such a manner as to cause the blood to circulate once more; in other words, an artificial circulation is set up. Now there are only three vascular areas which require consideration for our purpose, and I place them in order of urgency: (1) Pulmonary, supplied by the right ventricle; (2) central nervous, supplied by the left ventricle; (3) cardiac, supplied by the left ventricle through the coronary arteries.

(1) I place the pulmonary first because it is no good perfusing the tissues with blood unless that blood is oxygenated, and in order to oxygenate the blood the lungs must be ventilated with air. It is therefore essential to supplement our artificial circulation with an artificial respiration; and of methods of artificial respiration, I think the performance of perflation, or blowing air into the lungs through a tube inserted into the trachea through the larynx will be found most convenient. The ordinary Sylvester method is an alternative.

(2) A consideration of the central nervous system has a highly important bearing upon the ultimate success or failure of cardiac massage. The central nervous tissue is probably the most sensitive to loss of blood. We may take it that the

* Read before the Medico-Legal Society.

central nervous system, and especially the brain, will not stand cessation of the circulation for a longer period than five minutes without risk of serious damage. The centres in the bulb and spinal cord will survive longer, but if the restoration of circulation be delayed beyond five minutes, even though the circulatory and respiratory functions be efficiently restored, severe cerebral symptoms are likely to occur which seriously jeopardize the recovery of the patient. The symptoms are mainly delirium and muscular spasm or coma, with incontinence of urine and fæces, to which the patient generally succumbs. A case has been reported in which the artificial circulation was only set up 13½ minutes after syncope, and in which the patient recovered completely after fourteen days of severe cerebral symptoms; this is a unique case, but it shows that the performance of massage is not altogether hopeless even after a considerably longer period than five minutes.

(3) I consider the coronary circulation last, because the heart possesses an extraordinary attribute of retaining its excitability, even after prolonged anæmia, and not only so, but the automatic mechanism which governs the rhythm and sequence of the heart is readily restored. This has been proved many times in many ways, both in the intact animal and in the excised heart perfused with a suitable fluid. As regards man, there is on record a case in which the heart of a man was made to beat, feebly it is true, twenty-four hours after he had been executed by hanging.

It will be evident to you that it is no use attempting to restore a heart which is incapable of functioning. If the heart fails, for instance, from a non-volatile toxin either manufactured within the body or introduced into the circulation, it is obvious that massage is useless; massage will not get rid of the poison. So also it is useless to restore the heart when the failure is secondary to the permanent failure of other organs, as in severe shock (where the primary lesion is vascular), or in any condition in which other vital functions are seriously affected.

Cardiac massage is, in fact, in practice confined to certain cases of heart failure which take place upon the operation table, when all facilities are available for its prompt applica-

tion. Such cases, I think, come mainly under three headings, viz., asphyxia, extreme overdose with a volatile anæsthetic, and chloroform syncope. In the case of asphyxia the heart stops from want of oxygen; if it has not completely stopped then artificial respiration alone will supply this want, but after complete arrest cardiac massage in addition is the only hope; it is completely successful in experiments upon animals. So also in the case of an overdose of a volatile poison, such as ether or chloroform used as an anæsthetic; the breathing ceases before the heart is finally arrested, and here again the primary necessity is oxygen, which artificial respiration will supply; but if the signs of over-dosage are disregarded then the heart will stop completely, and an artificial circulation must be set up by massage; in my series of twelve experiments upon cats, overdosed with chloroform to complete arrest of the heart, massage was in every case successful. Artificial respiration alone is successful in the vast majority of instances of over-dosage, but it is conceivable that cardiac massage may be required in rare instances in which the evidence of overdosage has not been promptly recognized.

It should be noted that a volatile poison such as chloroform is excreted through the lungs when the circulation through these organs is restored, and so the body is relieved of the overdosage, but cardiac massage would be entirely ineffective in the case of a non-volatile anæsthetic such as hedonal, just as it is ineffective in connection with an autogenous toxin.

The main use of cardiac massage has been its application in cases of "chloroform syncope." This is a sudden and distinctive form of heart failure, unconnected with overdosage; the heart fails because the ventricles pass into a condition known as fibrillation, when they become absolutely incapable of propelling blood through the arteries. There is always a chance of spontaneous recovery from this condition, but after the lapse of two minutes there is no other hope of recovery except by cardiac massage; there is no other remedy; artificial respiration alone is useless. The way in which massage acts in this condition is as follows: The ventricles have a natural tendency to escape from fibrillation whilst their tissues are supplied with properly aerated blood, and massage, by maintaining the coronary circulation, affords a prolonged

opportunity for the exercise of this tendency. As a fact, in my series of 29 experiments on cats a successful result was obtained in every case. The duration of the massage before recovery occurred varied from less than a minute up to a maximum of 48 minutes.* In dogs the results are not nearly so satisfactory, but there is good reason to believe that the human heart resembles the cat's heart in respect of its susceptibility to recovery,† and that therefore the results should be good when a proper technique is observed.

As regards technique, it is obvious the heart must be properly grasped and squeezed, both right and left ventricles, and this can be done most effectually by passing the hand into the left pleural cavity through an incision made in the attachment of the diaphragm to the left costal margin. Attempts at compressing the heart from below the diaphragm are mere waste of time, although a few such attempts have been successful. This effective compression of the heart is the main pivot upon which success or failure turns; but success cannot be expected unless an effective artificial respiration is also maintained throughout, a point, I am afraid, which has been too often neglected. I read an account recently of a "surgical miracle" . . . An operation for enlarged tonsils terminating in chloroform syncope. The surgeon opened the abdomen and massaged the heart under the diaphragm. After this had been going on for ten minutes he perforated the diaphragm and performed direct massage. After a further ten minutes the heart beat normally, but the patient never recovered consciousness. The "miracle" would have been better worth recording if valuable time had not been wasted doing subdiaphragmatic massage. It is evident that direct massage applied within the five minutes time limit would have saved this patient. It was demonstrated that the heart could be restored, and with nerve centres undamaged by prolonged anæmia there would be no reason for non-survival.

In another case massage was commenced an hour and a half after syncope, and the heart resumed its beat, but the patient did not survive. This is merely playing with massage,

*When massage is prolonged, occasional short interruptions are beneficial.
†"Heart," 1920, vii, 175.

but I mention it to show how imperfectly the limitations of massage are appreciated even at the present time.

In another report of a fatality I find the doctor assured the coroner that every possible remedy was tried before resorting to massage. In this way we cannot look for success. If massage is done at all it must be done promptly and effectively. The recorded complete successes are not many in number, but I am convinced there should be many more. No doubt we cannot look for the same results in man in the operating theatre that we get in cats in the laboratory. The conditions are somewhat different, but the principles are the same, and only require proper application.

Let me now briefly repeat the main factors of success.

(1) Massage should be commenced within five minutes of the onset of syncope—this in the interest of the nerve centres.

(2) Heart compression, to be effective, should be performed by the hand in the left pleural cavity, and the right ventricle compressed as well as the left.

(3) An effective artificial respiration must be maintained throughout.

(4) Any cardiac poison present must be a volatile one. The heart must be capable of functioning, and all the other vital organs must be in working order.

In conclusion, I may remark upon the public interest which has been taken in this revival of the apparently dead. It becomes difficult to draw a line between life and death, or to give an exact definition of death; perhaps we may say that real death is death of the tissues, but this is a matter I prefer to leave you to consider and decide to your individual satisfaction, or, it may be, to your dissatisfaction.

At the March 18th meeting of the Royal Society of Medicine, when a discussion took place on The Possible Substitutes for Cocaine, Dr. H. H. Dale, who opened the discussion, stated that he had private information of a new local anæsthetic which had been produced in Germany.

Dr. A. L. Flemming has been appointed Lecturer of Anæsthesia at the Bristol University, and Mr. S. R. Wilson has been named in a similar capacity at the Manchester University.

EDITORIAL.

WITH this number the *British Journal of Anæsthesia* completes the First Volume of its existence, thus reaching Milestone Number One along a road which hitherto was new and untried.

When the idea of a medical periodical of this sort was first broached it was realized that there were many questions to be answered satisfactorily before plans could be safely undertaken to put the project into execution. There was little doubt as to the desirability of such an undertaking, but could sufficient support be obtained in so restricted a field; and, further, would it be possible to secure enough high grade contributions to fill a moderately large number of pages every quarter?

These questions have answered themselves in so far as Volume One is concerned. As regards the future we should like to point out that it is very much in the hands of anæsthetists generally. We take it that it is now felt to be a matter of some importance that our specialty continue to possess an organ of its own to act as its mouthpiece, as well as to assemble and present, at regular intervals, all that is instructive and of pertinent interest. Also, that it is desirable to be able to record the results of research workers abroad alongside those of our own.

These functions have all been attempted in the present volume, with what measure of success it is not for us to say.

There is this to be emphasized. Our pages are by no means restricted to certain writers or contributors, but, on the contrary, are open to all and sundry, for the publication of ideas or facts of value or interest. A glance at our quarterly bibliography will be remindful of the enormous amount, as well as great variety, of work being done in many quarters, and this should suggest new fields for research and investigation.

We desire to be more than a mere recorder of ideas. It is hoped that by placing the world of anæsthesia before anæsthetists generally it will aid in considerable measure to encourage research and investigation on the part of many who,

for the lack of such a mirror, would fail, as it were, to see the reflection of the many possibilities.

We repeat that our pages are open to every type of worker, but we are particularly anxious to encourage those who are standing on the threshold and hesitate to make a beginning. It is realized that, if the specialty of anæsthesia is to assume the status it deserves, it will be necessary to add a constantly increasing number of recruits to the already honourable list of those at present in the field. EDITOR.

RECTAL ADMINISTRATION OF ETHER.

During the late war, and after, I have been in the habit of giving rectal ether in suitable cases. The cases in which I have given this were one of breast amputation, gall-bladder cases, trephining, tongue and jaw cases, glands in neck, and amputations. Before one has recourse to rectal ether the state of the bowels must be closely gone into beforehand. Rectal ether must not be given to one who has loose bowels. I know this to my cost. I gave it to a case of Syme's amputation on a man who concealed from me the fact that he had some years ago suffered from amœbic dysentery. The rectal ether set up a recurrence of the malady, from which he died ten days later.

My *modus operandi* at the Liverpool Royal Infirmary is thus: The colon is thoroughly washed with a soap and water enema on the morning of the operation. It may take two or three washings out, and then a rectal tube is passed into the rectum, and, through a funnel fixed into the free end, the following fluid is poured in two hours before the time for operation: chloretone, gr. 5; ether and olei olivæ, of each ʒii. The funnel is then removed, and the free end, clamped with a pair of forceps, is left in the rectum. Then, half an hour before the operation, a hypodermic of atropine sulphate, gr. 1/100, and morphia tartrate, gr. $\frac{1}{3}$, is given. Then, twenty minutes before operation, the following mixture is poured into the rectal tube through the funnel, which has again been inserted into the free end: ether, 4 ozs., olei olivæ, 2 ozs. This must be poured in not faster than 1 oz. per minute. Sometimes the patient forces it out, but a few whiffs of chloroform stops this. The patient must not be moved on to the table until the ether

has taken effect, which generally is in twenty minutes. The rectal tube is left in the rectum and the funnel removed; the free end clamped with forceps, and if there should be any signs of collapse during the operation the forceps are removed, and the rectal tube allowed to empty itself, but I have seldom occasion to do this. The after treatment is simple. The solution is drawn off by the rectal tube, and the bowel irrigated by a soap and water enema, and this should be followed by an injection of 5 ozs. of olive oil.

The advantages of rectal ether in mouth and trephining cases are supreme, as the anæsthetist is completely out of the way of the operator. ARTHUR JOSEPH O'LEARY.

ANÆSTHESIA FOR DRESSING WOUNDS AFTER OPERATION, AND ESPECIALLY FOR REMOVAL OF GAUZE PACKING.

My attention has for a long time past been attracted to the immediate suffering and after-shock caused to patients by the withdrawal without an anæsthetic of gauze packing with which wounds or cavities have been tightly plugged at the time of operation. The withdrawal generally takes place a few days after this event, and at a time when the patient is feeling better in himself and is gaining in confidence. The pain of the slow dragging of the gauze over the sore surface is intense, and the shock correspondingly great, insomuch that the patient may groan and sweat, and is not uncommonly "shocked for the rest of the day." I have heard the patient so describe the condition, and say that he will never forget it. Why should he ever have cause to remember the occasion when, by administering a little "gas" or other anæsthetic for a minute or two, the gauze or plug can be removed painlessly from some abdominal region or prostatic cavity or from nose or sinus? The prevention of this added shock to the patient avoids nervous and physical strain, which in itself is an important factor in the after care, and does not break continuity of confidence in the surgeon's future manipulations. Is it not well to think of the patient's point of view, and the possibility, nay the duty, of saving him cruel and needless pain after, as well as at the time of, operation?

W. J. MCCARDIE.

ABSTRACTS OF CURRENT ANÆSTHETIC LITERATURE.

Current Researches in Anæsthesia and Analgesia, Feb., 1924.

Anæmia in relation to surgery and anæsthesia. WM. H. GILBERT.

Some effects of narcotics on spirogyra. Prof. FRANCIS E. LLOYD, Dept. of Botany, McGill University, Montreal.

Clinical scope and utility of carbon dioxid filtration in inhalation anæsthesia. R. M. WATERS.

Obstetric shock. A. H. MILLER.

The value of nirtous oxid-oxygen anæsthesia in oral surgical operations. STERLING V. MEAD.

Observations on general and local anæsthesia in face and jaw surgery. ARCHIBALD L. MILLER.

Myocardial deficiency from an anæsthetic standpoint. J. L. YATES.

Anæsthesia Supplement, *American Journal of Surgery*, January, 1924.

Observations on 900 cases of intravenous anæsthesia. A. Lehrnbecher, Nurnberg, Germany.

*Ethylene as a general anæsthetic. W. EASSON BROWN.

*The use of atropin as a preventive of respiratory sequelæ. MARY A. LEAVITT.

*Psychology in anæsthesia. JOHN T. BUETTNER.

The goitre risk and a simplified technique of local anæsthesia. JOHN HUNT.

Keeping anæsthetic records and what they show. JOHN S. LUNDY.

Ethylene as a general anæsthetic.

In this paper Brown of Toronto reports his experiments with the use of gas on animals. He found that a mixture of 80 per cent. ethylene and 20 per cent. oxygen depressed the animal and caused it to lie on its side. Respiration at first was slightly quicker but soon became normal. He anæsthetised mice, rats, guinea-pigs and small rabbits, and cats and dogs were narcotized for periods as long as two hours.

Considerable time was spent in endeavouring to discover if ethylene might, without warning, terminate fatally, and it was found that poisonous doses were always shown by a slowing and falling respiration, thus giving ample time for a lessening of the concentration by adding oxygen.

Ethylene gas is now placed extensively on the market in America, and many of the manufacturers of anæsthetic apparatus advertise its use in connection with their machines.

The use of atropin as a preventive of respiratory sequelæ.

Dr. Leavitt gives an outline of the work along this line conducted at a large general hospital in Boston for the past two years in an endeavour to eliminate respiratory sequelæ following operations. She reports several hundred cases with but one instance of post-operative pneumonia. Every possible effort is made to operate only in cases free from respiratory symptoms, but this failing, the following procedure is carried out:—

A hypo. of $\frac{1}{4}$ gr. morphin and $\frac{1}{150}$ gr. atropin is given an hour before operation; the patient is put under with gas-oxygen-ether sequence and kept under ether as lightly as possible compatible with the work to be done; another $\frac{1}{150}$ gr. of atropin is given at the close of the operation, and this dose is repeated every four to six hours for 48 hours, if the patient can stand it, that is, if the dryness caused is not too pronounced.

With the exception of the case of pneumonia mentioned the only respiratory sequelæ met with were very mild and of short duration.

Psychology in anæsthesia.

Buettner re-states the case for giving sufficient consideration to the mental side of patients while administering the anæsthetic. He well points out the importance of allaying fear in the patient's mind, and urges tact and gentleness in dealing with timid cases and especially children. He emphasizes the need for quiet during and immediately following anæsthesia.

California State Journal of Medicine, San Francisco, Jan., 1924.

Effects of posture on relaxation under anæsthesia. C. B. Palmer.

Palmer has gone into this matter very extensively and, as a result of observation in something like 10,000 cases, he concludes that, if proper attention is paid to the posture of the patient during induction and maintenance of anæsthesia, better relaxation and smoother anæsthesia will be obtained. He further asserts that the post-operative discomfort will be less.

Johns Hopkins Hospital Bulletin, Feb., 1924.

A chemical study of a case of chloroform poisoning. H. J. Stander.

Stander states that since 1894 there have been three other cases at the clinic, and of these two were fatal, both showing typical central necrosis of the liver. The first symptoms of poisoning in all cases were nausea and vomiting 18 to 24 hours after the administration of

the anæsthetic, following which jaundice set in, then drowsiness and coma; or first the patient was irrational, violent and later comatose. The heart functioned fairly normally. The liver was large and tender in all cases, and there was a leukocytosis of about 20,000. In the three fatal cases death ensued from two to six days after the anæsthetic.

The treatment in the non-fatal case was calcium lactate gr. xv every two hours, and later 5 per cent. glucose solution by the Murphy method, 2,500 cc. of this solution having been administered.

He concludes with the belief, as a result of the study of these cases, taken in conjunction with the work of Opie, Whipple, and others, that a diet rich in carbohydrates and milk, and restricted in fats, is advisable before chloroform anæsthesia.

Monatsschrift für Geb. und Gynäkologie, Berlin, Nov. 1923.

Prevention of chloroform syncope. STRUBE.

Strube advocates spraying the nose with a preliminary 1-5 per cent. cocain spray as a routine in general surgery wherever chloroform is to be used. He thinks that chloroform syncope may be prevented thus by allaying nasal irritation caused by this anæsthetic.

Policlinico, Rome, Dec. 15, 1923.

Spinal anæsthesia and retention of urine. I. DI PACE.

Di Pace calls attention to a case of retention of urine following spinal anæsthesia. The retention lasted two weeks. He attributed this condition to injury, by the needle, of the sacral nerve.

Chugwai Iji Shimpo, Tokio, July, 1923.

Cerebrospinal fluid after chloroform. SHYOSHIRO OHI.

The author made chemical examinations of cerebrospinal fluid after chloroform anæsthesia, and reports finding a remarkable increase of the H-ion concentration. This same increase he discovered following a death from same.

Journal of the American Medical Association, Chicago, Feb. 9, 1924.

Ethylene and oxygen as an anæsthetic for infants. JOHN D. LUNDY.

He reports four cases in which he found the respiratory rate curve of each patient to be radically different from that of other patients. He does not think nitrous oxide has been as satisfactory in his hands, as ethylene for abdominal work in infants, especially if the patient

is not a good risk. He concludes that in the administration of gas anæsthesia for infants it is urgently necessary to watch the colour, listen to the respiration, palpate the pulse, and measure the blood pressure; and he believes that in using ethylene in all types of risks, both young and old, it is in the weak patient and the bad risk that the advantages are best demonstrated.

Archives of Surgery, March, 1924.

Studies in exhaustion: vi. *Septicæmia*. G. W. Crile.

This article is one of a series of papers in which Crile sets out experimentally to demonstrate his hypothesis that "an animal or a man who has first been exhausted by exertion, emotion, hæmorrhage, asphyxia, anæsthesia or loss of sleep succumbs more readily to infection, and an animal or a man exhausted by infection succumbs" to the conditions named more readily. He, therefore, thinks it important to discover whether the exhaustion due to infection differs from the exhaustion from emotion, exertion, etc., etc.

In the case of ether and nitrous oxide, diphtheria toxin was administered to four animals under full ether anæsthesia, and one under full nitrous oxide anæsthesia. In each case the animal was killed after the anæsthesia had been continued for four hours, and he concluded that, as a result of his examinations of the brain, liver and suprarenals, continuous ether and nitrous oxide anæsthesia diminish the histologic changes produced by a toxin. Excellent illustrative photomicrographic reductions accompany the article.

La Presse Médicale, Feb. 13, 1924.

Anæsthesia with ethylene. By E. Papin and L. Ambar

The ideal anæsthetic does not yet seem to have been found, the potent ones being relatively dangerous and the safe ones not sufficiently powerful. Ether and chloroform offer many advantages, for owing to the potency they enable even the most difficult subjects to be anæsthetised, and they provide a relaxation which will satisfy even the most exacting surgeon; they are responsible, however, for occasional immediate and more frequent remote complications. Nitrous oxide, on the other hand, is practically innocuous, but it is a weak anæsthetic in so far as, in the absence of reinforcement with such drugs as morphia and hyoscine, it is apt to give but poor relaxation; deep narcosis with this gas is associated with asphyxia more often than administrators realise, the common result being an initial rise and a subsequent fall of blood pressure with various degrees of nausea, vomiting, and general depression. Being dissatisfied, then, with the reagents at our disposal we determined to try ethylene

because experiments performed on dogs by Schafer, Breton, and one of us proved that it was more powerful than nitrous oxide. As regards administration we found it closely resembled nitrous oxide and that it was essential to be able to vary the proportion of oxygen at any moment. Our technique was as follows: The gas bag being filled with ethylene, the patient was allowed to breathe for a minute or so and the bag was then emptied to remove the carbon dioxide of respiration, and again filled with ethylene and just enough oxygen to prevent cyanosis; after five or six minutes sleep supervened; after this stage was reached we added oxygen only in sufficient quantities to obviate asphyxia, and ethylene only when the patient tended to come round.

The course of anæsthesia was as follows: After two or three minutes there was a stage of excitement with incoherent conversation, followed by a repetition first of phrases, then of words, and finally of syllables; after from five to ten minutes analgesia and muscle-calm were established and certain operations could be performed, but perfect anæsthesia with complete relaxation was not established before from 15 to 20 minutes. Arterial tension was not affected, and the patients' colour remained normal.

As to sequelæ they were very slight; vomiting occurred once only in 58 cases, and there was no suggestion of pulmonary or renal trouble.

A. L. FLEMMING.

Revue de Chirurgie, No. 2, 1924.

Epidural anæsthesia. By PIERRE MOCQUOT.

This form of anæsthesia, although invented and practised in France in 1901 by Sicard and Cathelin, is now seldom used in that country, but the author, after some months' experience of it, is of opinion that it is of distinct value in certain directions.

Cathelin's first attempts were made with cocaine and failed because the analgesia obtained was not sufficiently complete, and Chepault obtained results which were too variable to be considered satisfactory. In 1909 Stoeckel, in Germany, found that with novocaine and adrenalin, in parturition, pain was abolished without interference with uterine contractions, and that delivery could be rendered almost imperceptible. In 1910 Laewen insisted that for success with this method it was important to employ a comparatively large dose of the drug, as regards both strength and quantity, and to limit its use to "low" operations, Schlimpert having had as many as seven complete failures in a series of 93 "high" anæsthesias. Following Germany, America took up the method and employ it to a considerable extent at the present time, and it seems probable that the discredit into which it has fallen may be justifiable as regards the high type but not as regards the low variety.

In 54 cases Mocquot and his co-workers met with four complete failures, three incomplete analgesias, and 47 successes, in which they

were able to operate upon the anus, the lower rectum, the vulva, vagina, and perineum, and upon the male genital organs.

Various complications have been reported such as collapse, vomiting, headache, etc., and a certain number of fatalities have occurred. From Germany, Freusberg reports 10 deaths in 4,200 cases of epidural anæsthesia, in 3,450 of which novocaine was the drug used. At least three of these 10 deaths were directly due to the anæsthetic, and in two of them the dura was punctured, being abnormally low. In some of the 10 cases where death occurred the quantity of novocaine exhibited was large, being as much as 80 or 90 cg. Eymer reports a case of a robust woman who was operated on for an ovarian cyst, and in whom death from heart failure took place quite suddenly 10 minutes after the operation had commenced. She was 27 years old, and at the post mortem examination no cause of death was revealed. Eymer's practice is to use large doses of novocaine and repeated hypnotics.

According to Wiedopf death is generally attributable to (1) Intravenous injection; (2) too large a dose of novocaine, especially in feeble subjects already under the influence of hypnotics; or (3) wounding the dura.

Mocquot recommends a 2 per cent. solution of novocaine of which 15 to 20 cm. or 30 to 40 cg. of the drug is sufficient for an adult. His formula is: Novocaine 60 cg., Sod. Bic. 15 cg., Sod. Chlor. 10 cg., Water to 30 cm.; 6 or 7 drops of 1 in 1000 sol. of adrenalin being added. A. L. FLEMMING.

Deutsche Zeitschrift für Chirurgie, Leipzig, Nov., 1923.

Late chloroform injuries. J. VORSCHUTZ.

Vorchütz states that in these cases a few days after the operation, which was regarded as successful, there was a slight rise of temperature and restlessness accompanied by slight jaundice and albuminuria. Then come delirium and coma. Forty-eight of his 57 cases were abdominal operations, and he thinks that the chloroform injury was due to the toxic action of the chloroform on the solar ganglion. Extensive experiments which he conducted on rabbits and dogs bear out his contention that chloroform is particularly dangerous in all abdominal conditions, as well as for the type of nervous patients. He regards the slightest derangement of the liver or kidneys as especially contraindicative of the use of chloroform or any mixture of chloroform. Drugs which induce sweating and diarrhœa form a logical treatment, and thus pilocarpin is suggested.

The report of Stander, of Johns Hopkins (abstracted in this number), notes a somewhat similar set of symptoms in his cases.

Münchener Medizinische Wochenshrift, Munich, Jan. 11, 1924.

Glucose injections and ether anæsthesia. KUTSCHA-LISSBERG.

Kutscha-Lissberg injected 10 cc. of a 50 per cent. solution of glucose intravenously, and 0.01 gm. morphine subcutaneously from

six to twelve hours before an ether anæsthesia. He mentions that even in alcoholics there was no excitement. Less ether is used. Unfortunately, in the 100 cases reported, there were 11 pneumonias and 13 per cent. of bronchitis. He thinks bad weather and poor heating were responsible for these results.

***The Canadian Medical Association Journal*, Oct., 1923.**

The effects of ether anæsthesia on afferent paths in decerebrate animals. ALEXANDER FORBES and RICHARD H. MILLER.

From the laboratories of physiology of the Harvard Medical School.

These two investigators set out to determine whether the contention of Crile and Lower " that ether anæsthesia offers no protection to the brain cells against the effect of trauma " was correct.

At Dr. Cannon's suggestion they recorded galvanometrically the action currents in the afferent nerve paths in the decerebrate animal. In such a preparation operative procedures and stimulation of sensory nerves may be performed with or without ether without causing pain.

The transection is performed through the mid-brain and the main afferent paths to the brain reach the cut surface in the mesial fillet. A large peripheral afferent nerve is stimulated and the electrical disturbances in the fillet are recorded with a string galvanometer, connected up with the exposed end of the severed brain stem.

The experiment was performed first without ether and then repeated under deep surgical anæsthesia.

The typical response obtained from the galvanometer without general anæsthesia was a double one—a slight initial excursion which represents the arrival of the impulses in the medulla, and a later large excursion due to the passage of the impulses along the fillet. The administration of ether reduced or abolished the second response. The decrease was appreciable even before the corneal and flexion reflexes disappeared, and there is usually complete disappearance of the response before the pinna reflex vanishes. The effect cannot be on the nerve fibres themselves and it would appear that Sherrington's view that the ether acts on the synapses is correct.

It would seem that under deep anæsthesia very few of the central neurones receive impulses on peripheral stimulation, and that ether is effective in protecting the brain against damage by sensory impulses. The authors similarly investigated the effect of magnesium chloride in producing general anæsthesia and of calcium chloride in neutralising its action.

Their early work in this direction would suggest that magnesium chloride is a dangerous and unsatisfactory anæsthetic, and is apt to cause sudden paralysis of respiration. Further it is not as effective as ether in reducing afferent stimuli. It seems to act more on the motor than the sensory side.

If calcium chloride is injected before respiratory failure is complete the animal is rapidly restored. S. R. WILSON.

SOCIETY REPORTS.

ANÆSTHETIC SECTION OF THE ROYAL SOCIETY OF MEDICINE, March 7th, 1924.

Professor STORRM VAN LEEUWEN, of Leyden, read a paper On The Anæsthetic Properties of Purest Ether. He first became interested in the subject right after the war as a result of rumours which were prevalent that the narcotic effect of ether was due to impurities present rather than to the action of the ether itself. Manufacturers had directed their efforts towards producing an ether that should be as chemically pure as possible, and, as a result of these reports, a number of them had approached him with the request to go into the matter in an experimental way, and to inquire into the facts. He obtained, in the open market, a number of samples which, upon examination, were found to differ only slightly in their composition, and he also discovered that none was absolutely chemically pure. He then set about preparing an ether that would fulfil, as far as possible, the requirements of a pure ether. He then learned that the non-narcotic action of pure ether was found not to be proved. Further experiments with chemically pure ether and the commercial brands developed the fact that the same effects were produced narcotically with both types.

He then directed his attention to the impurities found in commercial ethers. Methyl ethyl ketone, if given alone, is much more toxic than if given with ether, and if ketones were present less ether was required for narcosis. Certain other impurities were irritating and unsuitable for narcosis. In some commercial ethers peroxides were formed after exposure for some time in direct sunlight. Among those found to be free from peroxides were Cotton-process ether and Ethanesal, as well as the ether prepared by crystallization. Upon mixing pure ether with benzidene no peroxides were formed, and Professor van Leeuwen suggested that in order to stabilize ether a small amount of some other substance should be added. He concluded that pure ether differed in no way from ordinary commercial ethers as regards narcotic action.

Dr. R. L. MACKENZIE WALLIS said that although he had believed that pure ether was the ideal anæsthetic he found that the purer the ether the less anæsthetic effect it produced.

Dr. E. LANGTON HEWER agreed that this was so in clinical practice. He had experimented with different samples without having previous knowledge as to which was the pure one, and he had found that best results were obtained from a pure ether to which ketones had been added. As regards the chemical composition of the substance eventually known as Ethanesal, Mr. Chaston Chapman investigated a sample purchased in the open market and found it to

contain only slight traces of peroxides, the chief impurities being ketones, which were present to the extent of 1.3 per cent.

Dr. CHARLES HADFIELD stated that as he had read three different accounts of the formula of ethanesal he should like to know its exact composition.

Professor FINNEMORE stated that experiments which he had made some seventeen years ago on the purification of ether proved that pure ether was very unstable, but that it was made much more stable by the addition of a small quantity of alcohol. He added that the question of the testing of ether should be taken up and that standards required should be formulated by the Society. The Government should be urged to permit the manufacture of ether from pure ethyl alcohol without the financial penalties now in vogue.

Mr. H. E. G. BOYLE, by means of a chart showing an analysis of 10,000 cases of anæsthesia with ethanesal alone or with the addition of other anæsthetics, demonstrated that the results obtained compared favourably with other ethers.

Dr. F. E. SHIPWAY invited attention to recent American claims that pure ether was a perfect anæsthetic.

At the meeting of the London Association of the Medical Women's Federation on March 11th, there was a general discussion on anæsthesia.

Dr. H. N. PAYNE said she preferred ether to chloroform on grounds of easy administration and safety. She thought patients preferred gas, and she induced with this and followed up with closed ether. For toothless patients in the Trendelenberg position, in the late stages of long operations and in thyroid cases, she preferred the open method.

Mrs. A. GILLIATT preferred induction with chloroform or C.E. mixtures for nose and throat operations.

Mrs. MARGARET BREDY demonstrated the Looseley apparatus for the use of closed ethyl chloride. She thought this was a useful half-way house between nitrous oxide and chloroform. The most important signs to watch were changes in respiration, as well as alteration of colour, especially to a waxy pale colour. Ethyl chloride, having a cumulative effect, it was unwise to push its administration till the pupil was fixed, central and dilated. She strongly advised against the administration of a second dose during the same operation as she knew of a fatality which, she believed, was caused in this manner.

Mrs. TINDAL-ROBERTSON, discussing spinal anæsthesia, said that the injection of stovaine was liable to cause a drop of blood pressure which might cause trouble in a patient badly shocked before operation. On the contrary, if no shock was present to begin with, spinal anæsthesia actually diminished shock.

Dr. ENID MOORE advised slow induction in administering gas and

oxygen. Statistics at the Infants Hospital, where gas and oxygen was used exclusively for abdominal operations, showed fewer fatalities than where other methods were in vogue.

DEATH UNDER NITROUS OXIDE AND OXYGEN.

R. C., aged 72. Dec. 5, 1923. Fractured neck of left femur. Anæsthetic given for reduction of displacement and putting up in plaster of Paris.

In view of his age and the house surgeon's statement that he was "a bit chesty" gas and oxygen was given.

During induction there was a short cough at each expiration. The anæsthetic lasted 20 minutes. He was somewhat cyanosed in spite of having 50 per cent. of oxygen. Towards the end the breathing became shallow, the colour bad and the pulse feeble. The mask was removed but the condition got worse and the patient died on the table two or three minutes after the anæsthetic was stopped.

Post-mortem the lungs were slightly œdematous. Larger bronchi had rather thickened walls but did not contain any exudate. Tracheo bronchial glands were anthracotic. Pericardium covered by considerable layer of fat. Epicardial fat also increased. Heart not enlarged, muscle somewhat flabby but no myocardial lesion. Coronary arteries healthy. Mitral and aortic valves normal. Kidneys normal. Liver rather small (40 oz.). Spleen large and flabby. On section Malpighian bodies greatly hypertrophied.

The death was most unexpected as the patient's condition beforehand did not appear to be bad. The cyanosis noticed during anæsthesia was only slight. In an ordinary case of ether anæsthesia it would have passed almost without comment, and is only mentioned here because of the fatal result, and also because it was in marked contrast to the usual rose pink colour of patients under gas and oxygen. Asphyxia was certainly not the cause of death. The interesting question is: Why did the heart fail? Was it anything to do with the anæsthetic, was it fat embolism due to movement of the broken bone, or was it the cardiac inhibition of the medico-legal experts?

I should very much like to hear of any other similar cases, and other people's opinions as to the degree of responsibility of the anæsthetic in causing death. Theoretically I suppose gas alone cannot kill a patient except by asphyxia, and since with the addition of oxygen this danger is removed, it ought to be, and is claimed to be, the very safest of all anæsthetics. But when a case like this comes under one's personal notice it makes one wish to hear other opinions, as the question of allocating the responsibility of causing death to the anæsthetic or the operation is so difficult.

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BOOK REVIEWS.

"Local Anæsthesia." Prof. Dr. HEINRICH BRAUN. Henry Kimpton, 1924. 25/- net.

This is the second American, from the sixth German, edition, and is the translation of Dr. Malcolm L. Harris of Chicago. Since the original work appeared in 1905, writers on local anæsthesia have drawn largely from its pages, and with each succeeding edition Professor Braun's book has been more and more accepted as a great classic. Every phase of the subject is thoroughly elaborated, and practitioners of this form of anæsthesia will find therein the fullest particulars as to the various methods in vogue.

The breadth of the field is now practically unlimited. At Braun's clinic the proportion of operations of all types performed under local anæsthesia exceeds 50 per cent., and even this is surpassed in Dallinger's wards, where the proportion is said to be as high as 94 per cent.

These represent every type of case. Not more than a cursory reading of this work is needed to remind one that for the application of local anæsthesia much more than a mere acquaintanceship of the technique of injection is required. As Braun well puts it, it is necessary to possess a comprehensive knowledge of the sensory innervation of the operative field, and the subject must be taken up fully, the technique for each operation being studied in detail.

The work is replete with photographs, illustrations and drawings of the various methods as applied to all the principal operations, thus making the accompanying text clearer and easier to follow, and each chapter includes the necessary description of the sensory innervation concerned.

An interesting development of local anæsthesia is its application

to simple fractures and luxations. The author gives a list of 51 cases in which he applied this procedure. In only one case—a fracture of the tibia—did it prove unsuccessful.

This work should be a part of the book armamentarium of every anæsthetist. Not that he will be necessarily persuaded by it to forsake general anæsthesia, but, certainly, he should know something of alternative methods to resort to when occasion demands. He should also have a fair knowledge of the chemistry of the various agents available. Braun's book gives all this thoroughly.

"Anæsthesia in Dental Surgery." T. D. Luke, M.D., F.R.C.S. (Ed.), and J. Stuart Ross, M.B., F.R.C.S. (Ed.). Wm. Heinemann, Ltd. Fifth edition. 10/6.

The success of this work has called for another edition, which thus brings the teaching and practice of dental anæsthetics up to date. The death of Thomas Davy Luke placed the sole responsibility for preparing the present volume upon Dr. Ross, who is to be congratulated on maintaining the high standard set by previous efforts.

After reviewing briefly the history of anæsthesia details are given in relation to the choice of anæsthetics for dental operations, and the author rightly emphasizes the danger in the employment of chloroform for routine use. A chapter is devoted to the law in relation to anæsthetics, and stress is laid upon the need for systematic training in dental anæsthesia. The author is correct in insisting that no one, be he doctor or dentist, is a safe anæsthetist who has not given serious attention to the subject, and who has not devoted extra study to it above that required for surgical anæsthesia.

The dental student or practitioner will find the book all that he requires for his special field, while the medical practitioner will find in it just that information which will help him to adapt his knowledge of surgical anæsthetics to the requirements of dental work.

"Nitrous Oxide-Oxygen Analgesia and Anæsthesia in Normal Labour and Operative Obstetrics." $ 2.50. National Anæsthesia Research Society, Lake Shore Road, Avon Lake, Ohio.

This is a tastily bound monograph published under the editorship of Dr. F. H. McMechan and the publication committee of the above-named society, for the benefit of all concerned in safer and more efficient obstetrics and anæsthesia. Every phase of anæsthesia in relation to obstetrics is covered, but especial attention is paid to the value of nitrous oxide-oxygen. A very good case is made out for resort to this combination in labour and in all obstetrical procedures, and both practitioner and anæsthetist will find the work valuable as a complete and up-to-date exposition of the views and practice of leading authorities.

The Society is to be congratulated on its initiative in bringing out a Monograph of this character, and one has no hesitation in commending it to all those interested in anæsthesia and analgesia in their relation to obstetrics.